COLORADO BUILDING GREEN
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Project Profile

Alred A. Arraj U.S. Courthouse
by Audrey Lengel, The RMH Group

Sustainable Design from the Engineer's Perspective.

When the Alfred A. Arraj U.S. Courthouse opened in October 2002, few people knew it was the culmination of nearly a decade of appropriations, design, and construction work. In fact, the initial contract for this 10-story landmark was awarded to the design team of Anderson Mason Dale in partnership with Hellmuth, Obata + Kassalbaum in 1994. Over the nearly decade-long design and construction period, the courthouse was adapted to respond to the evolution of sustainable design and the LEED program. In effect, the project came to be a laboratory for LEED design and construction, and the very accomplished design team learned and adjusted as the project moved forward.

While the whole design team had to be flexible, the mechanical and electrical engineers faced the added responsibility for much of the building's energy efficiency. Steve Bickmore, P.E., Building Systems Division Manager of The RMH Group commented on the challenges. "When we started down the sustainable design path, very few buildings and just a handful of people had been through the process. It pretty much felt all new to us to go through the green checklist and the LEED 1.0 worksheet. Add to that, the sustainable goal had to be balanced with other design constraints and priorities."

Design commenced with a micro-programming and planning phase, requiring close coordination with the client and participation in numerous working conferences and reviews. With that work complete, the project was iced down during a 23-month departmental and Congressional review period and funding appropriation. During this two-year hiatus, the General Services Administration experienced near tectonic shifts in two design criteria – security and green design. The

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bombing of the Alfred P. Murrah Federal Building in Oklahoma City heightened awareness of security shortcomings in Federal properties throughout the U.S. It also expedited funding for Denver's new courthouse, spurred on by the city's prominence as a regional Federal justice center.

It was also in the mid-1990s that the General Services Administration took notice of the growing green design movement. With new performance criteria retrofitted into the program for the Arraj Courthouse, one of the first tasks as the project resumed was the convening of what was dubbed a Green Building Panel to assess green building design opportunities. This panel comprised many of the nation's leaders in sustainable design, including the chair of the still-young USGBC. While the LEED protocol was not yet in place, the Green Building Panel evaluated options by brainstorming through different performance categories, much along the same lines as LEED. These were:

+ Site and Transportation
+ Energy – Building Design
+ Energy – Electricity
+ Energy – Heating, Cooling, and Ventilation
+ Materials
+ Indoor Air Quality
+ Water Utilization
+ Occupant Productivity
+ Facility Operations
+ Construction

The GSA designated the courthouse would be a showcase for sustainable design and directed the design team to use "the latest available proven technologies for environmentally sensitive design, construction, and operation." In response, the Green Building Panel's issued a report proposing an ambitious and all-encompassing palette of options. The report was distributed to the entire design for review, and every item was evaluated and run through a cost/payback model.

The design that emerged from these ideas was tempered to create a sustainable, yet executable, solution. From an engineer's perspective, a number of the ideas were in conflict with each other or with the limitations of the site and urban environment. Code restrictions and stringent security requirements made other less attractive.

The greatest challenge for the mechanical and electrical engineers was the building's less than ideal orientation. RMH's lighting designer Mark Rudiger, LEED AP, observed, "The building's orientation was one of the biggest challenges to the project. We were locked into a city block. Add to that, part of the footprint had to be left to accommodate a future wing, fur-

Project Data

Project Name	Alfred A. Arraj U.S. Courthouse
Project Type	Justice center
Project Location	901 19th Street, Denver, Colorado
Construction Completion Date	October 2002
Project Size	10-story structure fronted by two-story special proceedings pavilion, totaling 321,000 sf
Project Cost	$82 million
Owner	General Services Administration – Rocky Mountain Region Public Building Service
Key Participants	
Public agencies:	General Services Administration United States District Court of Colorado United States Marshals Service
Architect/Designer:	Anderson Mason Dale Architects Hellmuth, Obata + Kassalbaum, Inc.
Design Consultants:	The RMH Group, Inc. - Mechanical and Electrical Engineering; Lighting and Telecommunications Design Architectural Energy Corporation - Sustainability Consulting, Energy Modeling, and Daylighting Design Civitas, Inc. - Landscape Architecture Martin/Martin, Inc. - Civil/Structural Engineering E-Cube, Inc. - Commissioning
General Contractor:	PCL Construction Services, Inc.

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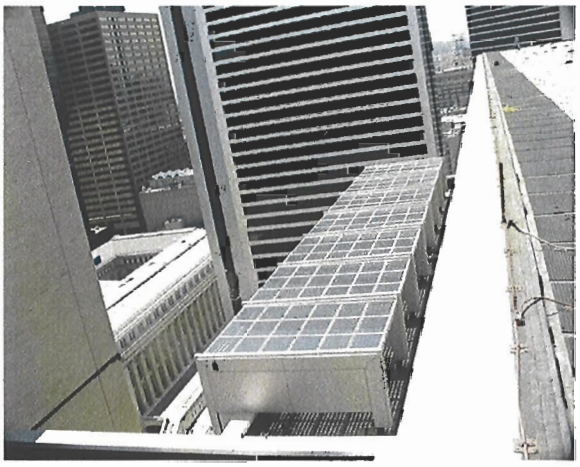
Sustainable Features - MEP

- The building is LEED registered and designed to achieve LEED Gold rating. The certification process may move forward this year.
- The displacement ventilation system utilizes a raised access floor to deliver low-velocity air at floor level, efficiently conditioning the space and removing air pollutants.
- Cooling and humidification loads are served by an indirect/direct evaporative cooling system supplemented by Xcel's downtown district chilled water.
- Different areas are lit by a combination of T-5 fluorescent lamps, compact fluorescents, and metal halide downlights. Photocell controls and electronic fluorescent dimming ballasts integrate the electric lights with abundant daylighting.
- Supply air volumes are adjusted according to the needs of different zones. All fans and pumps are fitted with variable-speed drives to reduce energy consumption during part-load operation.
- Low water-consuming lavatory faucets and water closets are installed throughout the building to minimize water use.
- A high-performance curtain wall on the court tower controls solar heat gain, visible light, and heat loss. Low-emissivity glazing delivers natural light while minimizing glare and HVAC loads.
- Roof-mounted photovoltaic panels produce electricity during sunlight hours, reducing peak electricity requirements.
- Daylighting is applied for both energy efficiency and architectural effect. Perimeter light shelves diffuse daylight onto the ceiling plane and adjacent architectural surfaces. Clerestory windows in the special proceedings pavilion illuminate the entry rotunda and backlight the ceiling in the courtroom.



ther constraining the building on the site and its layout."

The stringent security requirements posed another problem. According to Bickmore, "The sustainable design had to work hand-in-hand with the security requirements, which, like the green criteria, were a whole new set of parameters for the team to work through. Both sets of criteria were competing for dollars on the project."

To achieve an efficient design, the team applied a two-pronged strategy to first reduce energy loads and to then meet the reduced loads through high-efficiency systems and renewable energy sources. Among the high-efficiency systems are underfloor displacement ventilation and evaporative cooling. The courthouse represents a very large-scale application of both technologies. The displacement ventilation system uses a raised access floor to deliver low-velocity air at floor level, efficiently conditioning the space and removing air pollutants. In combination with all the other HVAC subsystems, the mechanical equipment placed a heavy demand on space throughout the building. Though not ideal, the supply for the courtroom displacement ventilation had to be combined with the VAV supply to save space. Best operation was obtained through dogged commissioning by E-Cube. Paul Watters, RMH's mechanical construction engineer, noted, "We were all learning. There simply wasn't room for a separate supply, so we had to compromise. E-Cube did a great job in getting it all to work."

RMH was also charged with lighting design, as well as integration with Architectural Energy Corporation's daylighting design through the building automation system. Daylighting is used extensively to provide the required ambient light levels within the judges' chambers, perimeter office spaces, and the public corridors on

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Sustainable Features - General

- The building's footprint was sited to minimize runoff. Its landscape functions as a self-contained ecosystem that does not require much care or irrigation and is populated with indigenous and xeric plants such as buffalo grass. Drip irrigation is used for the landscape's minimal watering needs.
- Hardscaping was constructed using sand setting, rather than concrete, to increase water absorption capacity and reduce stormwater runoff. Low-traffic perimeter areas use grass-block paving and crushed stone surfaces to the same effect.
- Local materials, such as native stone, and recycled-content material, including steel, make up much of the building's structure and exterior. The majority of the flooring materials are from recycled or native sources, including sandstone, cork, and recycled plastics.
- Interior finish materials were carefully selected based on their environmental and occupant impact, such as embodied energy, indoor air quality, and resource depletion. All paints and adhesives are low in VOCs. The maple paneling was specified from certified forests.
- The building's occupants are well served by public transportation, including light rail and buses. More than 20 percent of the staff uses public transportation or bicycle to work.
- The contractors implemented a recycling plan for metals, woods, paper, and other materials. The building's occupants have ready access to recycling bins on each floor for paper and cans.

each of the court floors. Rudiger found that a number of the judges were naturally apprehensive about how the lighting and daylighting would work together, given their limited experience with daylighting. To reassure them, a lighting mockup was carried out in the one courtroom that was completed prior to all other interior finish construction.

Fine-tuning for the special proceedings courtroom required another approach. The room's lighting consists of halogen downlights suspended in a curved perforated ceiling daylit from above and illuminated by linear fluorescent uplights. The stone finish of the wall behind the judge's bench picked up a strong reflection from the daylighting, and it was honed to a new finish to minimize the glare. "In the end, everything worked," said Rudiger. "If we'd started going for LEED, rather than thinking about LEED at mid-design, parts of the building would probably look and function differently."

It was everyone's commitment to sustainable design throughout construction, the laboratory for all design, that made the project a success. This success is recognized with several awards, including a GSA Environmental Awards in 2001 and a Renewable Energy in Buildings Colorado Awards, conferred by the Colorado Renewable Energy Society. The building was also earned an EPA Energy Star rating, and GSA may pursue LEED certification this year, with Gold in sight. GSA's goal to promote sustainable design and LEED for Federal justice facilities continues in downtown Denver. Next up: renovation of the Byron G. Rogers U.S. Courthouse, now in construction. This project, one of 50 selected throughout the U.S. for the prototype LEED for Existing Buildings application, is expected to earn a Silver rating.